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ABSTRACT

This study was designed to explicate the nature of the processes utilized by students when learning from textual materials when the text has been augmented by interspersing questions at various points. Sixty undergraduate students were randomly assigned to one of six treatment groups. The experimental treatments were: (1) questions shortly before, underlined answers (SBU); (2) questions shortly after, underlined answers (SAU); (3) no questions, but same underlined materials as SBU and SAU (NQU); (4) questions shortly before (SB); (5) questions shortly after (SA); and (6) no questions, no underlining (NQ). The subjects worked through the text at their own rate. They were not permitted to review the text. Each group was informed that they would be tested on how much content they could remember, and, upon completing the text, they were given a 40-question criterion test. The same test was administered to all subjects again five days later. The results indicated that performance on the immediate test was better than performance on the delayed tests, that retention of practiced items was higher than retention of nonpracticed items, that question position was not significant, and that all time differences among treatment groups were significant. (WR)

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The study reported here is one of several conducted or planned by the authors, designed to explicate the nature of the processes utilized by students when learning from textual materials when the text has been augmented by interspersing questions at various points. Studies investigating effects of questions in text have been conducted mainly under the rubric of mathemagenic activities or behaviors. The key experiment in the area was conducted by Ernst Z. Rothkopf of Bell Telephone Laboratories and reported in several versions (Rothkopf, 1965; 1966; 1972). Briefly, this study investigated the effects of inserting questions in text either before or after the content to which the question referred. Two post-test measures were collected, one which assessed the same information as that tested by the interspersed questions (practiced items) and another which assessed information not tested by the interspersed questions (non-practiced items). The questioned groups scored higher on practiced items (P) than a control group which read the text without interspersed questions. Furthermore, groups which received questions placed before the relevant content (QB) scored less well on non-practiced test items (NP) than groups which received questions placed after the relevant content (QA). This finding has been replicated several

times using different materials and subjects (See Frase, 1970, for a review) and appears fairly stable.

Rothkopf (1970) has argued that questions inserted in text alter the nature or character of the behaviors that students engage in while reading text. These behaviors are referred to as mathemagenic behaviors, behaviors which determine the nature of effective stimulation that the reader receives. Some mathemagenic behaviors can facilitate the attainment of specific instructional objectives (mathemagenic positive) or interfere (mathemagenic negative). Rothkopf (1970) has further stated that the character of mathemagenic activities has to be discovered for each separate instructional situation and for each instructional objective. Nevertheless, he argues, it should be possible to identify general classes of situations or objectives for which it would be possible to provide a general description of relevant mathemagenic activities. The present paper seeks to identify the nature of the mathemagenic behaviors in a quasi-instructional situation where the learner is reading text materials with questions interspersed.

Specifically we propose to examine P and NP retention of text under various conditions in order to test hypotheses concerning the processing strategies of learners. In the literature of the effects of adjunct questions on text learning, a number of variables have been examined such as knowledge of results, question frequency, question type, etc. (See Frase, 1970, for a review) but as yet no consistent picture of the precise processes students employ has emerged. The general strategy to be employed in our studies, of which this is the first, is to examine the

effects of other manipulations of the instructual setting (e.g., underlying critical content, instructions, guessing strategies, motivational level) on the question position effect. From an extended and integrated program of studies such as these we hope to be able to depict in a coherent manner the probable information processing strategies of students reading text with questions inserted.

In the present study, the effects of underlining those portions of the text which will provide answers to the adjunct questions was studied. Such a manipulation was expected to alter markedly the nature of the QB and QA treatments. Underlining should serve the purpose of directing S's attention to portions of the text critical to answering P items, hence increase P retention. The same function has been presumed for questions, especially in the QB condition. Would these effects be additive?

With respect to NP retention, the most common explanation for the advantage of the QA group over the QB group is that the QB group hunts only for answers to the adjunct question and ignores or pays less attention to the NP material. The QA group has to read or pay attention to all of the material since he is generally uncertain what content will be tested. Underlining, then, could be expected to reduce markedly the advantage of the QA group since Ss in this group could direct their attention to the underlined material and pay less attention to the NP material. Such an analysis would predict, then, that the advantage of the QA group on NP items would be less when underlining was also employed than when it was not.

Method

Materials

The materials selected were those previously used by Frase (1967) and adapted accordingly for this experiment. The material consisted of a continuous prose passage of biographical material about William James from Psychology: The Science of Mental Life, by Miller (1962).[1] The material was divided into twenty paragraphs, each paragraph on a separate sheet of 5 x 8 1/2 inch paper. Two sets of materials were produced - one version with and one without underlining. The Frase materials provided two multiple-choice questions (five alternatives) from each paragraph which required the recall of specific factual information from that paragraph. The two questions were constructed so as not to overlap in content. Twenty questions were used as practiced (P) questions on the post-test. These questions were inserted during the learning session for those groups which received questions before or after paragraphs. The other set of twenty questions was used to test non-practiced (NP) learning. The groups which received underlined versions had the answers to the practiced questions underlined in the text. The forty-item criterion text was mimeographed on five 8 1/2 x 11 sheets of paper. Twenty P and twenty NP questions were randomly interspersed throughout the criterion test.

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[1]Permission for using these materials kindly granted by Harper and Row, Inc.

Subjects

The Ss were sixty undergraduate students from three introductory educational psychology courses at Indiana University. Participation in the experimental studies was a course requirement. Ss were randomly assigned to one of six treatment groups, providing an N of ten for each treatment.

Procedure

The experimental treatments were as follows:

SBU. (Questions shortly before, underlined answers); just before starting each paragraph, S read the question for that paragraph and was instructed to guess the correct answer. After responding he read the next page and was told to check his response without looking back at the previous page. S was informed that portions of the text had been emphasized (underlined) in order to help learn the material.

SAU. (Questions shortly after, underlined answers); S read the paragraph with the underlined answers. S then was to mark the correct answer for the question on the following page. S was instructed as above about underlining.

NQU. (No questions, but same underlined materials as SBU and SAU); S was instructed to read the material, that portions of the text were emphasized in order to help learn the material, and that they would be tested on the material. A control group.

SB. (Questions shortly before); same directions as SBU except references to underlining.

SA. (Questions shortly after) same directions as SAU except

references to underlining.

NQ. (No questions, no underlining), same directions as CU except references to underlining. A control group.

Each S worked through the text at his own rate. Ss were not permitted to review the text. Each group was informed that they would be tested on how much of the content they could remember. S was asked to record the starting and finishing time on the text materials. Immediately upon completing the text, all Ss were administered the forty question criterion test. The same test was administered to all Ss again five days later.

Results

The data were analyzed by means of a four factor, repeated measures analysis of variance with repeated measures on Test (Immediate or Delayed) and Scales (Practiced or Non-Practiced items). Question position and Underlining were between subject factors. Two separate analyses were conducted, one with (3 x 2 x 2 x 2) and one without (2 x 2 x 2 x 2) the control groups included.

Analysis Including Control Group

Tests and Scales were significant ($p < .01$), while Question Position was not. The Underlining factor was marginal with $.05 < p < .10$. Performance on the immediate test was better than performance on the delayed test, better on P items then NP items, and better on the underlined version than on the non-underlined version. A significant ($p < .05$) Scales x Underlining interaction indicates that the

advantage of the underlined version is greatest on practiced items. One other significant interaction was observed between Scales and Question Position. Based upon prior research, it had been expected that on Practiced items, the two questioned groups (QB and QA) would score higher than the control group. This was in fact the case although the difference was not as great as had been expected and did not reach significance. The NQ groups performed at a level somewhat higher than the QA groups, and significantly higher ($p < .05$ using Newman Keuls) than the QB groups on NP retention.

A separate analysis was conducted using time to complete the text materials as the dependent measure. No time differences occurred as a function of the underlining treatment, while for the question conditions, NQ was fastest (as expected, since they had no questions to answer), SB was the next fastest, and SA was slowest. All time differences among treatment groups were significant ($p < .05$ using Newman Keuls).

Analyses Excluding Control Groups

Underlining significantly facilitated total test score ($p < .01$) and this effect was greatest on the practiced questions as shown by a marginally significant ($.05 < p < .10$) interaction between Scales and Underlining. Alternatively, one might say that the retention of non-practiced items in the underlining and non-underlining groups was equivalent, but that on practiced test items the underlining group was superior. The fact that the main effect for Underlining was significant on this analysis and only marginal in the previous one indicates that underlining had its primary effect when used in conjunction with questions.

Retention of practiced items was higher overall than retention of non-practiced items ($p < .01$), as in the previous analysis. Question position was not significant, but there was a marginally significant ($.05 < p < .10$) interaction between Question position and Scales in the direction consistent with previous research. Inspection of this interaction reveals that question position had no influence upon P test items, but questions placed shortly after text segments produced increased retention of NP content.

Test, immediate or delayed, was significant ($p < .01$) as expected, with immediate retention being higher than five day retention. This factor also interacted with Scales and Underlining at a marginally ($.05 < p < .10$) significant level. This interaction appears to be an extention of the Scales x Underlining interaction reported above in which the advantage of the underlined group on practiced items is greatest on the delayed test.

Discussion

Our original view of the processes S employs in learning from text was of a rather specific set of information search strategies under rather direct control of features of the lesson materials. In QB conditions, Ss is presumed to enter the question into memory and rehearse it so that it will be available to him when he turns the page and locates the answer. When reading, S will search for or be sensitized to material which will answer the questions. Material not deemed pertinent to the answering the question is not processed to the same extent

as the pertinent information. When the pertinent information is located, it is processed or adapted to meet the demands of the question and it is this additional processing which makes the practiced material more memorable. Underlining was expected to facilitate S's search by pointing out the pertinent information. We expected underlining and questions to combine their effects and produce greater retention of practiced material and less retention of nonpracticed material than either manipulation would alone.

In QA treatments, S reads the material, trying, we believed, to remember as much of the content as he can since the pertinence of the material can not be determined until the question itself is encountered. When the question is encountered, S must retrieve and review the information stored and attempt to answer the question. This further processing of the practiced material makes it more likely to be remembered than nonpracticed material. The nonpracticed material has, however, been submitted to processing (e.g., rehersal) which is not as likely to occur in the QB condition. Hence, the retention of nonpracticed material should be higher for the QA condition than the QB condition. Underlining should alter markedly the character of the processes employed in the QA condition in that Ss now can determine pertinence of content prior to encountering the question.

This model seemed to handle fairly well existing data on learning from text with questions interspersed, but, of course, the viability of any model depends upon its ability to predict new data. In this study Question position interacted with Scales in a manner consistent

with previous research although the interaction did not reach conventional levels of significance. Underlining, too, functions about as expected on the basis of the model. Both questions and underlining appear to serve the function of directing S's attention to portions of the text critical to answering practiced items and both appear to facilitate retention of practiced items.

Other expectations from the model, particularly those predictions which were unique to this experiment, did not receive support. As outlined above, we had expected that the QB-QA difference on nonpracticed items would be reduced substantially by underlining. While there was some tendency in that direction, the necessary triple order interaction was not significant. It is possible that such effects would build up over a longer time or treatment but that speculation awaits further testing. We had also expected that questions and underlining would produce greater retention of practiced material and less retention of nonpracticed material than either manipulation alone. Again the necessary interaction was not significant.

A lack of significance on relevant interactions does not provide evidence against the information search model; only directly contradictory results can do that. Some factors which might have contributed to the lack of stronger effects with respect to information search are treatment length and S motivations. As mentioned above, the effect sought here might be expected to build up over time. Hence, the relatively short treatments employed here would not allow a conclusive test of the search model.

Motivation is certainly also relevant here. Ss in these experiments all appeared fairly interested in the experiment especially in one of three classes used. As Frase, Patrick, and Schumer (1970) have shown, high incentive makes mathemagenic behaviors relatively impervious to external manipulation. Some support for this interpretation comes from the fact that in this study the control groups scored as well as the questioned groups on practiced items whereas prior research has usually shown a strong advantage for questioning over no questioning on that measure. The incentive hypothesis is quite testable and will be pursued in the near future.

At any rate, the information search model of mathemagenic behaviors receives no strong support in this study. The possibility is raised that the strategies posited here come under the control of treatment manipulations (e.g., questions, underlining) more often under conditions of low incentive or arousal. Further experimentation is under way on the effects of other manipulations such as recall instructions, question type, etc. on mathemagenic processing. These effects will be compared with predictions from the information search model in the hope that a more coherent and complete picture of learner behaviors in this particular situation will emerge.

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